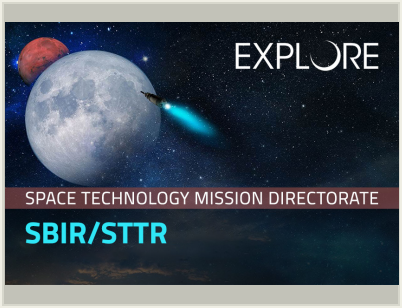
A Modular Electric Propulsion System with On-Demand Power Scaling, Phase I

Completed Technology Project (2011 - 2011)

Project Introduction

The Electromagnetic Plasmoid Thruster (EMPT) program demonstrated a next generation propulsion system based on the purely electromagnetic generation and Lorentz acceleration of a magnetically self-confined plasmoid. The Peristaltic Dynamic Acceleration (PDA) stage is an addition to the exhaust of the EMPT that takes an existing, translating plasmoid and adds directed, kinetic energy with a set of sequenced magnetic field coils. The EMPT creates a high-density, magnetized plasmoid known as a Field Reversed Configuration (FRC) using external RF antennas that produce a Rotating Magnetic Field (RMF) throughout the thruster. The large FRC plasma currents together with the radial magnetic field result in a large JxB force that rapidly accelerates the FRC propellant out of the thruster. The Dynamic Acceleration stage then initiates a pulsed magnetic field behind the FRC increasing the magnetic field pressure gradient. These pulsed field coils can very efficiently add kinetic energy to a magnetized, closed-field plasmoid and be used to increase velocity and average thruster power from 1 kW to greater than 20 kW, all without any changes to the original thruster. The EMPT will be operated at maximum ionization efficiency at 2 kHz. The PDA will then accelerate the high-mass plasmoid to the required mission velocities. In this way power can be added to the device incrementally depending on the mission and power available. This also enables a so-called dual mode thruster that can operate over a wide range of power, thrust, and specific impulse while still maintaining constant gas flow for very long life, deep space missions. The PDA allows for the incremental development and qualification of the thruster, dramatically reducing total costs. Finally, the ability to rapidly and cheaply increase the power of a space-qualified thruster by factors of ten allow for the propulsion technology to grow with the available power for NASA science missions.



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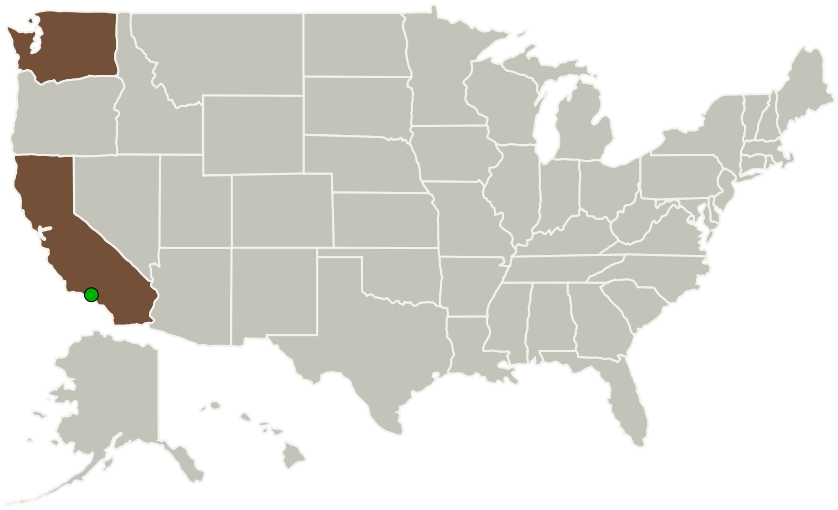
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
MSNW, LLC	Lead Organization	Industry	Redmond, Washington
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Washington

Project Transitions

February 2011: Project Start

September 2011: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137831)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

MSNW, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

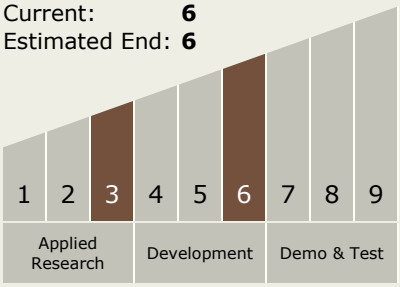
Carlos Torrez

Principal Investigator:

David Kirtley

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



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Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.2 Electric Space Propulsion
    - TX01.2.3 Electromagnetic

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System